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Enhanced Query Data Recorder (EQDR)– Networked Flight Recorder for the Future

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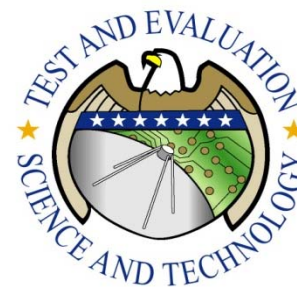
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14. ABSTRACT The Test Resource Management Center's (TRMC) Spectrum Efficient Technologies (SET) S&T program is sponsoring development of the Enhanced Query Data Recorder (EQDR), a network flight recorder that is intended to meet the future needs of the networked telemetry environment. EQDR is designed to support the "fetch" of recorded test data during a test without interrupting the ongoing recording of data from the test article vehicle network. EQDR advances the state of the art of recorder technology in several ways. First, it supports concurrent recording and retrieval of data at a high rate. Second, EQDR provides native support of the iNET TmNS message format. Third, EQDR enables parametric-level data retrieval, based not only on time interval and data source, but also on the content of the recorded data messages. EQDR enables selective, efficient retrieval of individual parameters using indexes derived from the actual values of recorded data. The key benefits of the network data recorder as implemented in EQDR are increased flexibility and efficiency of test in an environment with increasing demands on spectrum available for telemetered data. This presentation will describe the design of EQDR and the benefits of selective data storage and retrieval in the application of networked telemetry.					
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Test and Evaluation/Science and Technology Program Spectrum Efficient Technologies

Enhanced Query Data Recorder – Networked Flight Recorder for the Future

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T&E Need



- **Network data recorder that provides instantaneous access to recorded flight data without interrupting ongoing recording**
- **Parametric-level data retrieval for backfill of data dropouts and ad hoc requests**
- **Need for spectrally efficient retransmission**



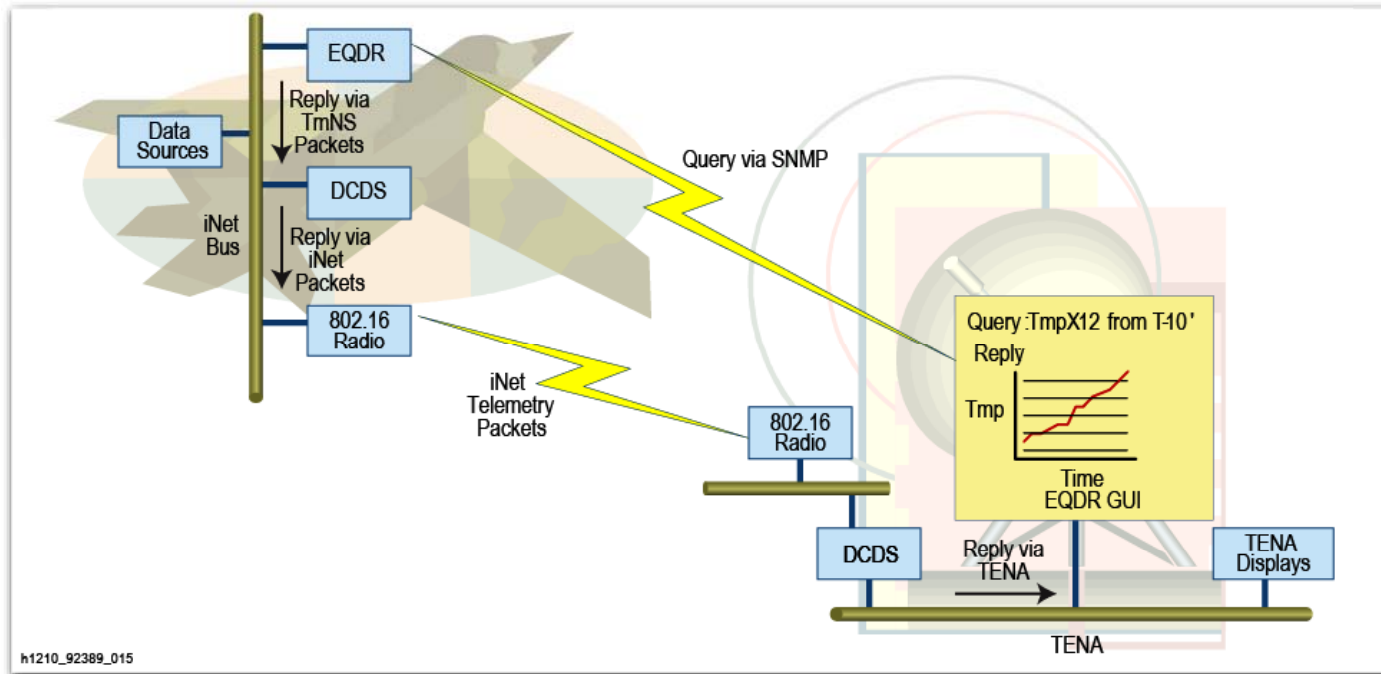
S&T Challenge



- **Recording data at high rates while at the same time allowing for concurrent, rapid and selective data retrieval**
- **Developing approaches to data indexing, storage, and retrieval that optimize overall system performance**
- **Developing ways to retrieve data based on complex criteria, including values of the stored data itself and derived values such as minimum, maximum, average within a time interval**
- **Parallelizing storage and retrieval mechanisms to enhance performance**



Project Description



The Enhanced Query Data Recorder (EQDR) will improve test efficiency and safety of flight during data dropouts, non-nominal modes of operation, and inter-maneuver periods



Project Description



- **Data dropouts**
 - Instantaneous retrieval and retransmission of lost test data or for backfill to improve completeness of control-room data for quick-look data analysis
- **Non-nominal modes of operation**
 - Efficiently retrieve recorded data not previously sent to ground to better understand “trends” of non-nominal behavior observed during the test
- **Inter-maneuver periods**
 - Retrieval of data for quick-look analysis to ensure test objectives met and data gathered before moving on to next test point



S&T Background (slide 1 of 2)



- **Network Data Recorder must:**
 - Record and retrieve data concurrently
 - Record at high enough rate to capture all data onboard the test article
 - *For spectrum efficiency, retrieve individual measurands quickly, with specificity and selectivity, as retransmitted data competes with real-time telemetry stream for limited bandwidth*



S&T Background (slide 2 of 2)



- **Existing Chapter 10 recorders store data by time interval and channel only**
- **Implications**
 - Retrieval also limited to time and channel
 - No other selection mechanism
 - No filtering based on values of measurands themselves
- **Today's current approach does not meet needs of future network data recorder**



Project Scope



Phase	Brief Description	End TRL
1	<ul style="list-style-type: none">• Determine optimal approach for data storage and retrieval• Develop underlying EQDR technology components• Demonstrate effectiveness and flexibility of EQDR components in lab-based prototype (e.g. desktop environment)	4
2	<ul style="list-style-type: none">• Port EQDR components to embedded system hardware more representative of aeronautical test environment• Optimize software performance• Increase multi-threading/parallelism in execution• Characterize performance of system on embedded hardware	5
3	<ul style="list-style-type: none">• Port EQDR technology to flight-capable hardware• Flight demonstration	6



Performance Testing Setup



- **Test Configuration**
 - Intel i7 610 @ 2.53 GHz, 4 Threads
 - 8 GB RAM
 - Windows 7 Professional SP1 64 bits
 - Java 7.0.3 64 bits
- **Generated Load**
 - Each Data Source has 2000 Data Items, average size 20 bits, 500 Hertz -> 20 Mbits/sec
 - We simulate 12 Data Sources -> 240 Mbits/sec
 - Maximum TmNSMessage size 80 Kbits
 - 20 TmNSPackages per Data Source
 - 100 Data Items per TmNSPackage

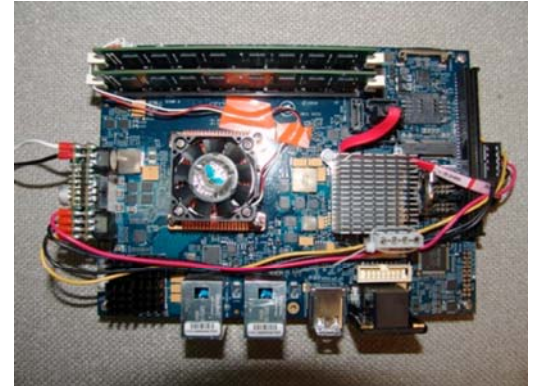
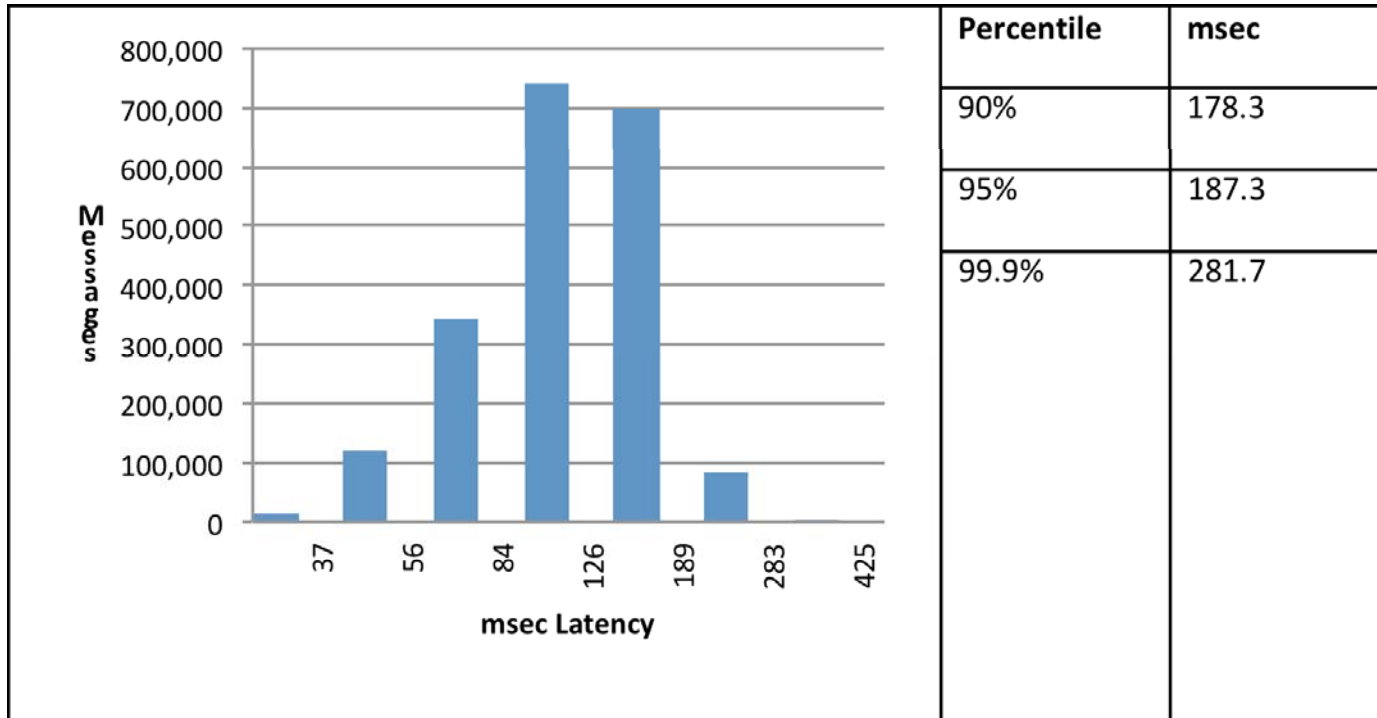


Photo taken by SAIC



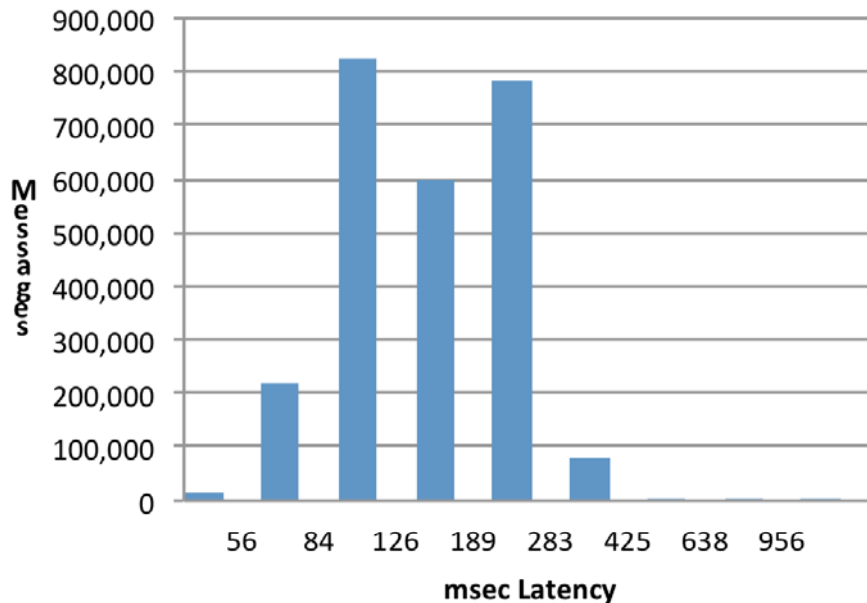
Performance 260 Mbits/sec Recording Rate (Target)



	CPU Load
System Total avg.	27.8%
EQDR Recorder avg.	17.7%
MySQL avg.	3.9%
EQDR Total avg.	21.6%



Performance at 480 Mbits/sec Recording Rate (Maximum)

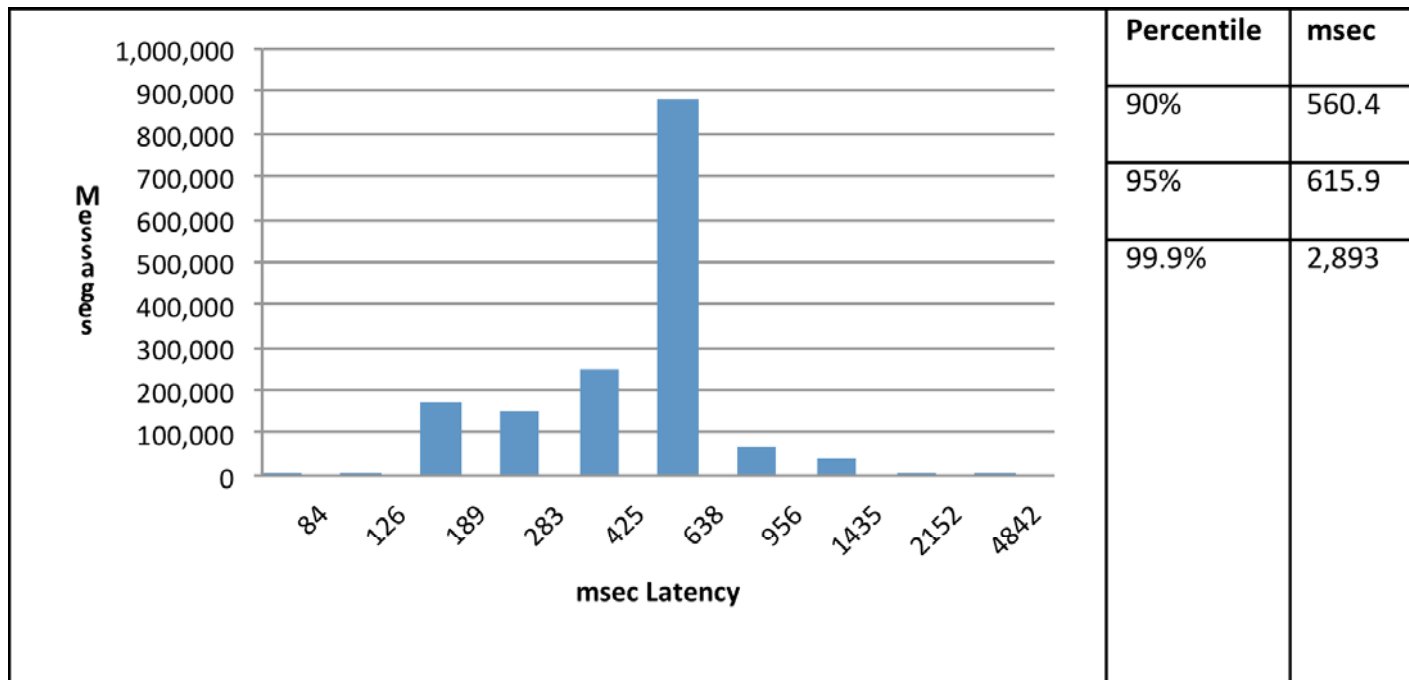


Percentile	msec
90%	251.6
95%	272.9
99.9%	630.7

	CPU Load
System Total avg.	50.1%
EQDR Recorder avg.	35.6%
MySQL avg.	7.0%
EQDR Total avg.	59.0%



Performance at 600 Mbits/sec Recording Rate (Peak)



	CPU Load
System Total avg.	68.5%
EQDR Recorder avg.	49.3%
MySQL avg.	9.7%
EQDR Total avg.	59.0%



Retransmission Performance



	250 Kbits/sec Retransmission	5 Mbits/sec Retransmission	20 Mbits/sec Retransmission
System Total avg. CPU Load	26.6%	27.4%	28.2%
EQDR Recorder avg. CPU Load	16.2%	17.6%	18.0%
MySQL avg. CPU Load	3.9%	3.9%	3.9%
EQDR Total avg. CPU Load	20.1%	21.5%	21.9%
Percentile	msec	msec	msec
90%	176.9	177.3	179.6
95%	185.9	186.6	187.0
99.9%	344.0	283.2	283.1

Concurrent recording (250 Mbits/sec) and retransmission



Summary



- The Enhanced Query Data Recorder (EQDR) will improve test efficiency and safety of flight during data dropouts, non-nominal modes of operation, and inter-maneuver periods
- Spectrum efficiency necessitates retrieval and retransmission of individual parameters
- EQDR enables data retrieval based on complex criteria, including values of stored data itself and derived values and statistical data
- Performance on Intel i7 610: 480 Mbits/sec recording with 60 Mbits/sec concurrent retransmission



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